AnsaldoSTS
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ATT-20
Audio Track Transceiver

US&S Part No.
N454052-3901 through N454052-3906

- **Installation**
- **Operation**
- **Troubleshooting**

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Revision History

REV.	DATE	NATURE OF REVISION
0	April 1997	Initial issue
1.0	June 2008	Revised to current template. Updated parts lists and drawings. Incorporated ECO EE-1223 (2/00). Miscellaneous minor grammatical changes. Proof read comments resolved.

Table of Contents

List of Figures

List of Tables

1. GENERAL INFORMATION

1.1. Introduction

This manual provides application, installation and maintenance information for the Union Switch & Signal Audio Track Transceiver, Model ATT-20.

The ATT-20 is a short-range transceiver operating in the audio frequency range of 12 to 20 KHz. The high frequency range was chosen to provide sharp block definition. The ATT-20 can be used in applications such as highway crossings, island circuits, switch lock release and general train detection in non-electrified and DC electrified territories. In most cases, insulated joints are not required and track circuits up to 300 feet in length can be realized. Units are available for operation in either shunt mode or series mode applications.

1.2. Physical Description

The ATT-20 is a single unit transceiver containing separate transmitter and receiver printed circuit boards, mounted on a common chassis. The chassis is housed in a sheet metal box. The top cover of the unit is the faceplate to which AAR terminal posts are mounted.

1.3. Specifications

1.3.1. Power Requirements

Power Supply Voltage: 9.8 - 15.2 Vdc
Maximum Ripple: 1 Vpp
Load Current: 600 mA.
Fuse: 3 / 4 Amp fast blow

1.3.2. Transceiver Characteristics

CAUTION

The ATT 20 may be operated from a constant potential rectifier (CPR) supply, batteries floating on a CPR, or an electronically regulated supply. Regardless of the supply used, a surge ripple filter (US&S N451590-0301) must be used between the supply and the ATT-20 Transceiver.

Shunt Mode Output Voltage:	1.0 Vrms (modulated) into a 5-ohm load
Series Mode Output Voltage:	0.25 Vrms (modulated) into a 1-ohm load
Available Operating Frequencies:	12.28 KHz, 15.0 KHz, 20 KHz.
Carrier Frequency Tolerance:	+ 0.5 %
Modulation Frequency (All Units):	390 Hz + 0.5%
Harmonic Output:	-30 dB at second harmonic with 12 ohm load in shunt mode 7 ohm shunt mode; 1 ohm series mode

1.3.3. Receiver Characteristics

Sensitivity:	70 mVrms (modulated signal) + 14 mV
Input Impedance:	7 ohms shunt mode, 1 ohm series mode
Output Voltage:	7.65 Vdc into 400 ohms

Table 1-1. Adjacent Frequency Rejection

ATT-20 Frequency (KHZ)	Adjacent Frequency of Concern (KHz)	Rejection of Adjacent Frequency (dB)
12.28	15.0	-18.0
15.0	12.28 18.0* 20.0	-30.0 -21.0 -27.0
20.0	15.0 18.0*	-44.0 -23.0

* Of concern where joint detectors are used.

1.3.4. Miscellaneous

Reverse battery protection:	Built-in
Operating temperature range:	- 40°C to +70°C
Maximum block length:	300 ft. shunt mode at 3 ohm/1000 ft. ballast; 150 ft. series mode at 3 ohms/1000 ft. ballast.
Recommended Relay:	PN-150B, 400 ohm coil, (US&S N322500-701)
Overall Dimensions:	Refer to Figure 1-1.
Mounting Hole Dimensions:	2¼" x 8½"
Weight:	4 lbs., 14 oz.
Terminal Connections:	AAR

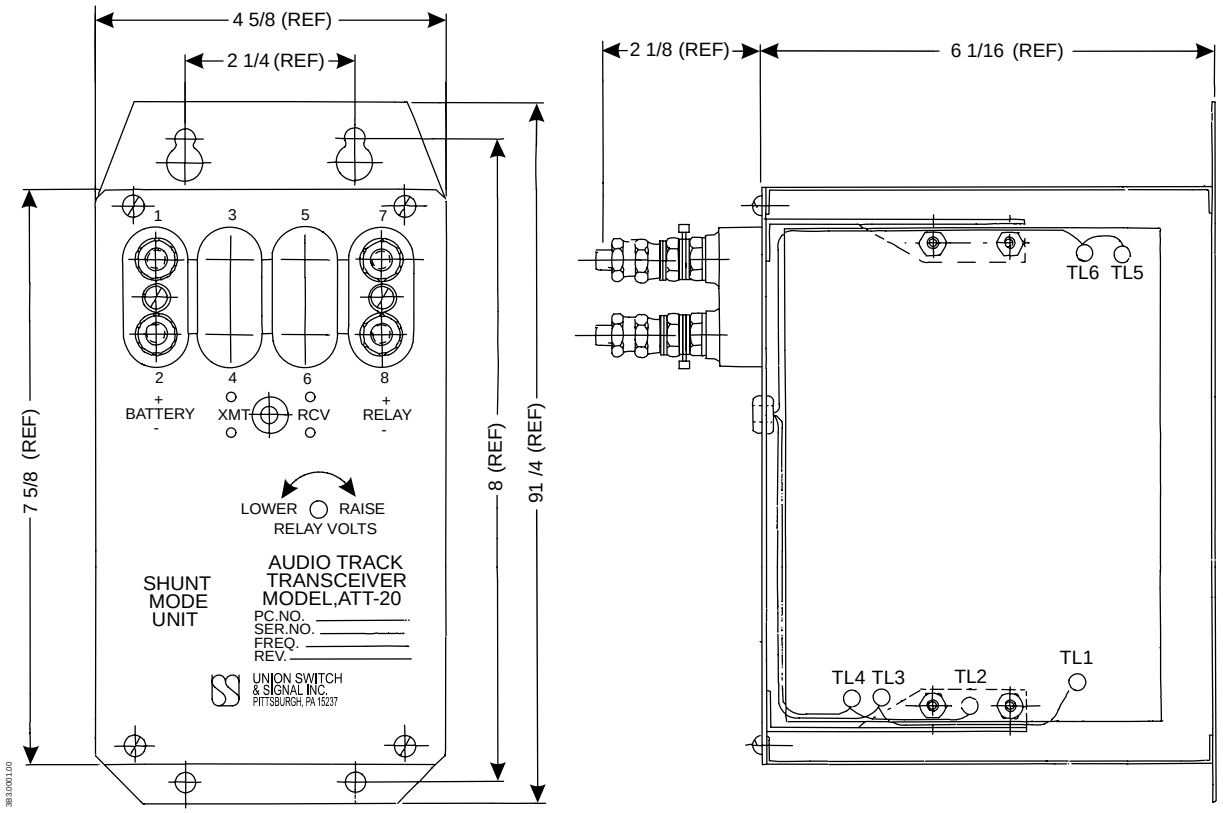

Figure 1-1. ATT-20 Dimensions


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2. APPLICATION, INSTALLATION, AND ADJUSTMENTS

2.1. General

This section provides information on the application of the ATT-20, as well as installation and adjustment procedures for the ATT-20 and related equipment. It is also critical that this section be read in its entirety prior to any application considerations.

2.2. Shunt Mode Track Circuit Application

In this application, the transmitter output and receiver input are connected by cable directly to the rails. The connection is made through surge protectors by twisted line pairs as shown in Figure 2-1. The point at which the transmitter wires are connected defines one end of the track circuit. While the other end of the track circuit is defined by the receiver connections to the track. The receiver detects the presence of a train by the loss of the audio frequency signal that is shunted away by the train axle.

The shunt mode of operation is defined as a vital application.

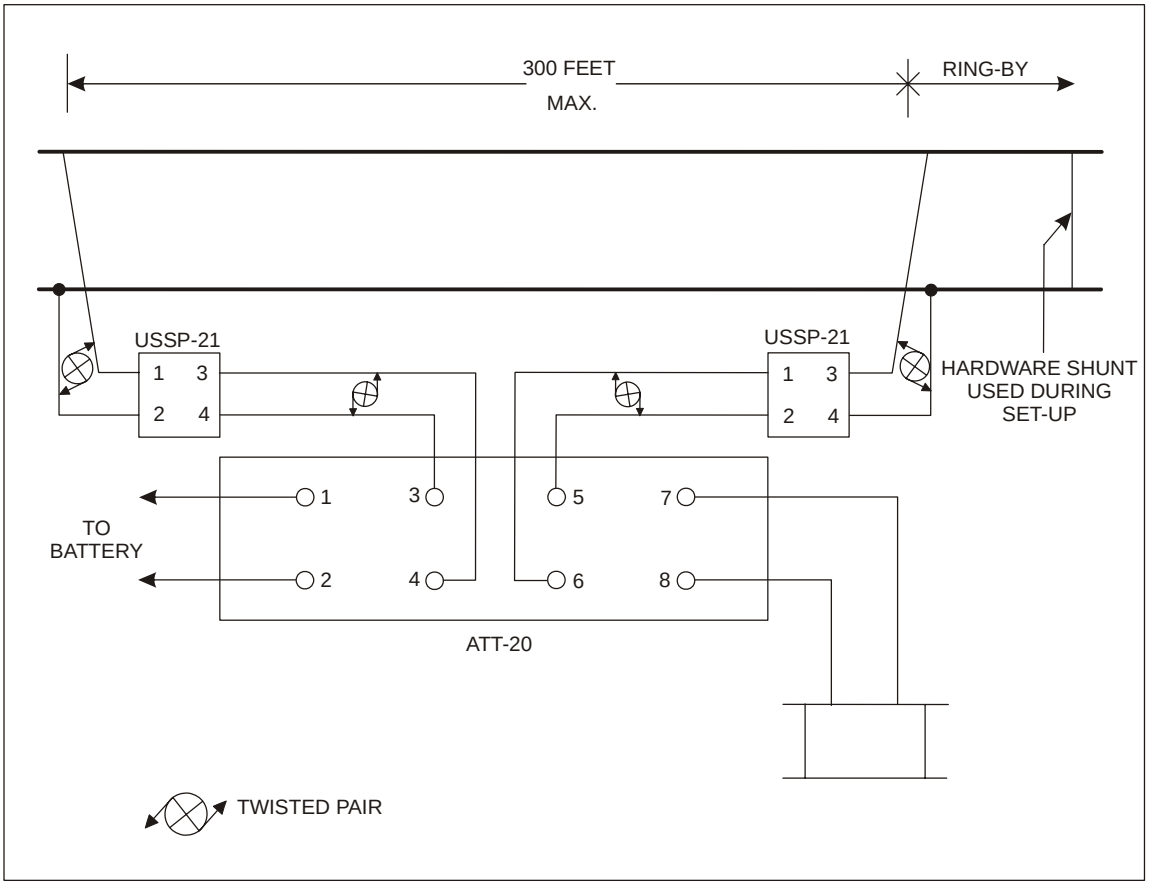

Figure 2-1. Shunt Mode Track Circuit Application

2.3. Series Mode Track Circuit Application

In this application, the transmitter and receiver are wired in sequence via a jumper on the ATT-20 unit. This jumper connects transmitter output terminal 4 to the receiver input terminal 6. The remaining transmitter output lead (terminal 3) and the remaining receiver lead (terminal 5) are twisted as a pair and each is connected to its respective rail (see Figure 2-2). The presence of a train axle across the rails completes the series signal path, thus detecting the approach of a train.

The series mode of operation is a non-vital application.

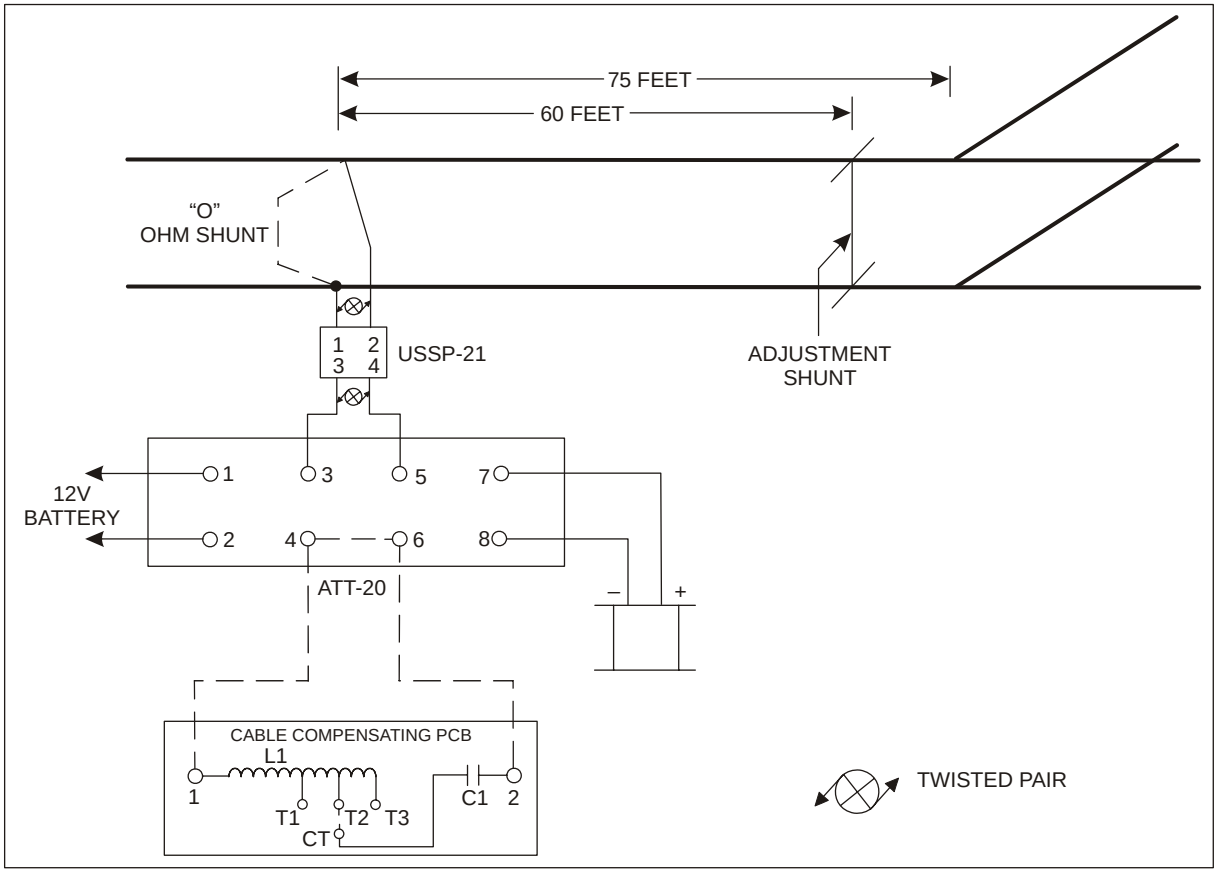

Figure 2-2. Series Mode Track Circuit Application

2.4. Terminal Connections

AAR type terminals are located on the top of the unit for making external connections. Refer to Table 2-1.

Table 2-1. Terminal Assignments

Terminal No.	Description
1	+ Battery
2	- Battery
3	Transmitter Lead
4	Transmitter Lead
5	Receiver Lead
6	Receiver Lead
7	+ Relay
8	- Relay

Internal wiring is accessed through a grometted hole in the faceplate. Also located on the faceplate is an access hole which is intended for setting transmitter gain. This is a simple adjustment and can be accomplished with a screwdriver.

2.5. Mounting Requirements

A convenient mounting bracket, which is an integral part of the case, provides four holes spaced 2-1/4 x 8-1/2 apart to facilitate wall, shelf or rack mounting.

2.6. General Considerations

a. Track leads to the transmitter and receiver must be a #9 AWG or heavier twisted pair.

b. Power supply must be 9.8 - 15.2 Vdc and capable of supplying 1 ampere. A surge ripple filter (US&S Part No. N451590-0301) must be used between any supply and the ATT-20. Power supply ripples must not exceed 1.0 Vpp.

c. Use higher frequency units when less ring-by is desired.

d. Provide lightning protection per Section 2.9.

e. The relay recommended to be used with ATT-20 is a vital PN-150B, US&S No. N322500-701, 400 ohm, plug-in type.

2.7. Shunt Mode Operation

CAUTION

When using the shunt track circuit configuration, do not repeat the use of the same frequency unless circuits are isolated by at least two (2) insulated points.

Where less ring-by is desired, keep the track circuit length to a minimum and use the shortest possible track leads. Refer to Figure 2-1 and Table 2-2 for shunt track circuit application.

2.7.1. Shunt Mode Installation

a. Connect transmitter terminals 3 and 4 to terminals 3 and 4 of the USS-21 surge suppressor. Continue the cabling to the track from terminals 1 and 2 of the USSP-21. Repeat the above procedure for cabling receiver input terminals 5 and 6 to the rails. All transmitter and receiver cables must be #9 AWG or heavier and used as a twisted pair. Ensure the combined lengths of the transmitter and receiver cables do not exceed 500 ft. Also, do not exceed block lengths of 300 ft.

b. Connect terminals 7 (relay +) and 8 (relay -) to the relay. The recommended relay to be used with the ATT-20 is a PN-150B, 400 ohm plug-in type, US&S Part No.: N322500-701.

c. If the ATT-20 is to receive its DC power from a battery or constant potential rectifier supply (CPR) or an electronically regulated supply, a surge ripple filter (Part No. N451590-0301) must be used as follows (on the next page):

d. Connect terminals 1 (+) and 2 (-) of the ATT-20 to respective "+DC" and "-DC" terminals of the ripple filter. Jumper terminals 2 to N on the ripple filter and cable terminals B (positive) and N (negative) to their respective battery bus or supply terminals. Lightning arrestor USG-A N451552-0101 should be across ripple filter terminals B and N. Refer to Section 2.9 for the details on lightning protection.

e. If the ATT-20 is to be powered from an electronic supply, this supply should be capable of delivering 1.0 ampere at 12 Vdc (on the ATT-20 side of the surge ripple filter) and be dedicated to the ATT-20 it is powering.

2.7.2. Shunt Mode Adjustment

a. Connect a hardwire shunt across the rails outside the defined block at the desired ring-by distance from the ATT-20 receiver track connections (terminals 5 and 6). Table 2-2 shows typical ring-by parameters for 3.0 ohm/1000' ballast and 0.1 ohm adjustment shunt.

Note

The adjustment shunt mentioned below is not a hard-wire shunt. This shunt must accurately represent the desired shunting sensitivity.

b. b. Adjust the ATT-20 transmitter output level through the access hole in the top cover until the relay is energized.

c. Remove the hardwire shunt from the rails.

d. Place an adjustment shunt across the rails at the receiver connection (not the ring-by distance). The relay should drop out. A compromise between the shunting sensitivity (adjustment shunt) and ring-by distance will be achieved per application.

e. Remove the adjustment shunt from the rails. The adjustment procedure is complete.

Table 2-2. Ring-by Parameters for 0.1 Ohm Shunting

Track Length (Ft.)	Total Cable Length (Ft.)	Typical Minimum Ring-By (Ft.)		
		12.28 KHZ	15.0 KHz	20.0 KHz
100	100	11	10	9
	300	14	14	13
	500	19	19	19
200	200	18	18	17
	300	21	21	22
	500	29	29	33
300	300	30	30	33
	400	35	36	41
	500	40	43	52

2.8. Series Mode Operation

Series track circuit locations operating at the same frequency must be separated by at least two insulated joints. A typical series mode application would be at a switch lock. Refer to Figure 2-2 for this application.

2.8.1. Series Mode Installation

a. Connect a jumper strap between terminals 4 and 6 on the ATT-20 when the total single conductor cable length from the ATT-20 to the track is less what appears in Table 2-3 below. If the cable length is exceeded, connect terminals 4 and 6 on the ATT-20 to terminals 1 and 2, respectively, on the cable compensating circuit board (N131002-01)

Table 2-3. Cable Length vs. Frequency

Suffix No. N451052-	Frequency (KHz)	Total Cable Length (Length x 2 cond.)	Jumper from Cable Compensating PCB to Terminal:
-3904	12.28	< 75 feet	T3
-3905	15	< 50 feet	T2
-3906	20	< 25 feet	T1

b. Connect terminals 3 and 5 to terminals 3 and 4 of the USSP-21 surge suppressor. Connect terminals 1 and 2 of the USSP-21 to the track at a point 75 feet from the switch points. All cabling from the ATT-20 to the track must be #9 AWG or heavier twisted pair.

c. Connect terminals 7 (relay +) and 8 (relay -) to the relay. The recommended relay to be used with the ATT-20 is a PN-150B, 400 ohm, plug-in type, Part No. N322500-701.

d. If the ATT-20 is to receive its DC power from a battery, constant potential rectifier supply (CPR), or an electronically regulated supply, a surge ripple filter (Part No. N451590-0301) must be used as follows:

If the ATT-20 is to be powered from an electronic supply, this supply should be capable of delivering 1.0 ampere at 12 Vdc (on the ATT-20 side of the surge ripple filter) and be dedicated to the ATT-20 it is powering.

2.8.2. Series Mode Adjustment without Cable Compensating PCB

a. Connect a hardwire shunt across the rails 65 feet from the ATT-20 track connections.

b. Adjust the ATT-20 transmitter output level through the access hole in the top cover until the relay is just energized.

c. Remove the hardwire shunt from the rails. The adjustment procedure is complete.

2.8.3. Series Mode Adjustment with Cable Compensating PCB

a. Place an "O" ohm shunt across the track connections at the feed end.

b. Connect an AC voltmeter (Vrms) across terminals 5 and 6 on the ATT-20.

c. On the cable compensating PC board, adjust the slug in pot core inductor "L1" until the voltmeter indicates a maximum.

Note

Depending on cable length, peaking of the signal might not be possible. After adjustment of inductor, place a small amount of RTV in the pot core adjuster area.

d. Remove the "O" ohm shunt.

e. Adjust track circuit as shown above in section 2.8.2.

2.9. Lightning Protection

Two lightning protection devices are to be used with the ATT-20. The track connections will be made through a USSP-21 secondary surge protection and the battery power supply line will be protected by a surge ripple filter which uses a USG-A lightning arrester across the power bus terminals.

The USSP-21 surge protector is wired to permit line-to-line protection using a low voltage arrester and line-to-ground protection using high voltage arresters. Internal circuitry of the USSP-21 also includes series line inductors as well as back-to-back Zener diodes for suppression of low voltage transients. The US&S part no. is N451552-0525.

The surge ripple filter consists of a series line inductor and a four-terminal capacitor with a selenium suppressor diode across its terminals. The four-terminal capacitor guarantees loss of power to the load should one of the capacitor leads or plates open.

The line-to-line arresters used across terminals 1 and 2 of the USSP-21 and terminals B and N of the Surge Ripple Filter are USG-A N451552-0101.

The line-to-ground arresters used across terminals 1 and 5, 2 and 6 of the USSP-21are USG-A N451552-0201.

Block wiring diagrams showing the wiring of surge and ripple protection for the ATT-20 in both the shunt and series modes of operation appear in Figure 2-3 and Figure 2-4, respectively.

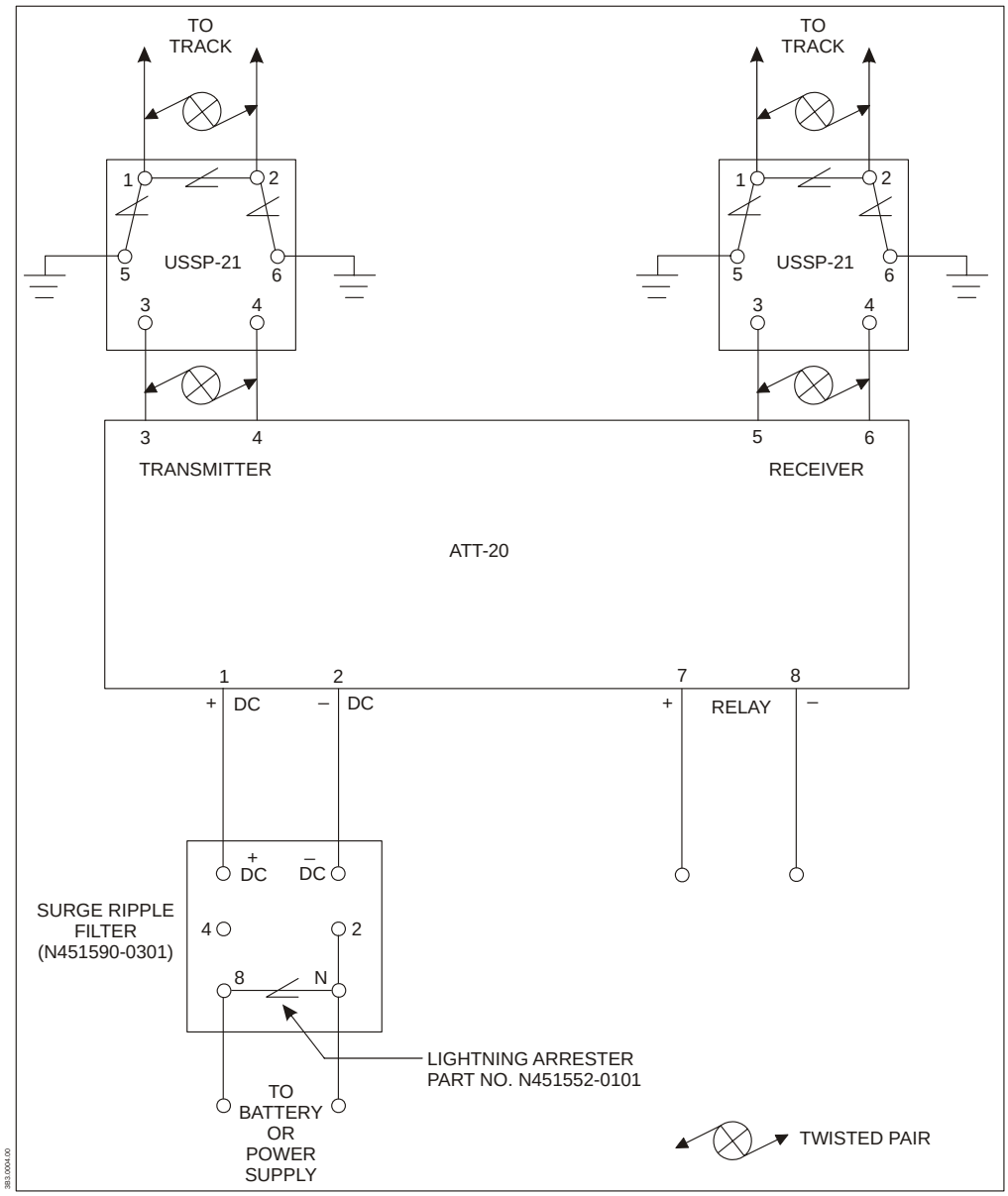

Figure 2-3. Lightning Arrester and Surge Ripple Filter for Shunt Mode Application

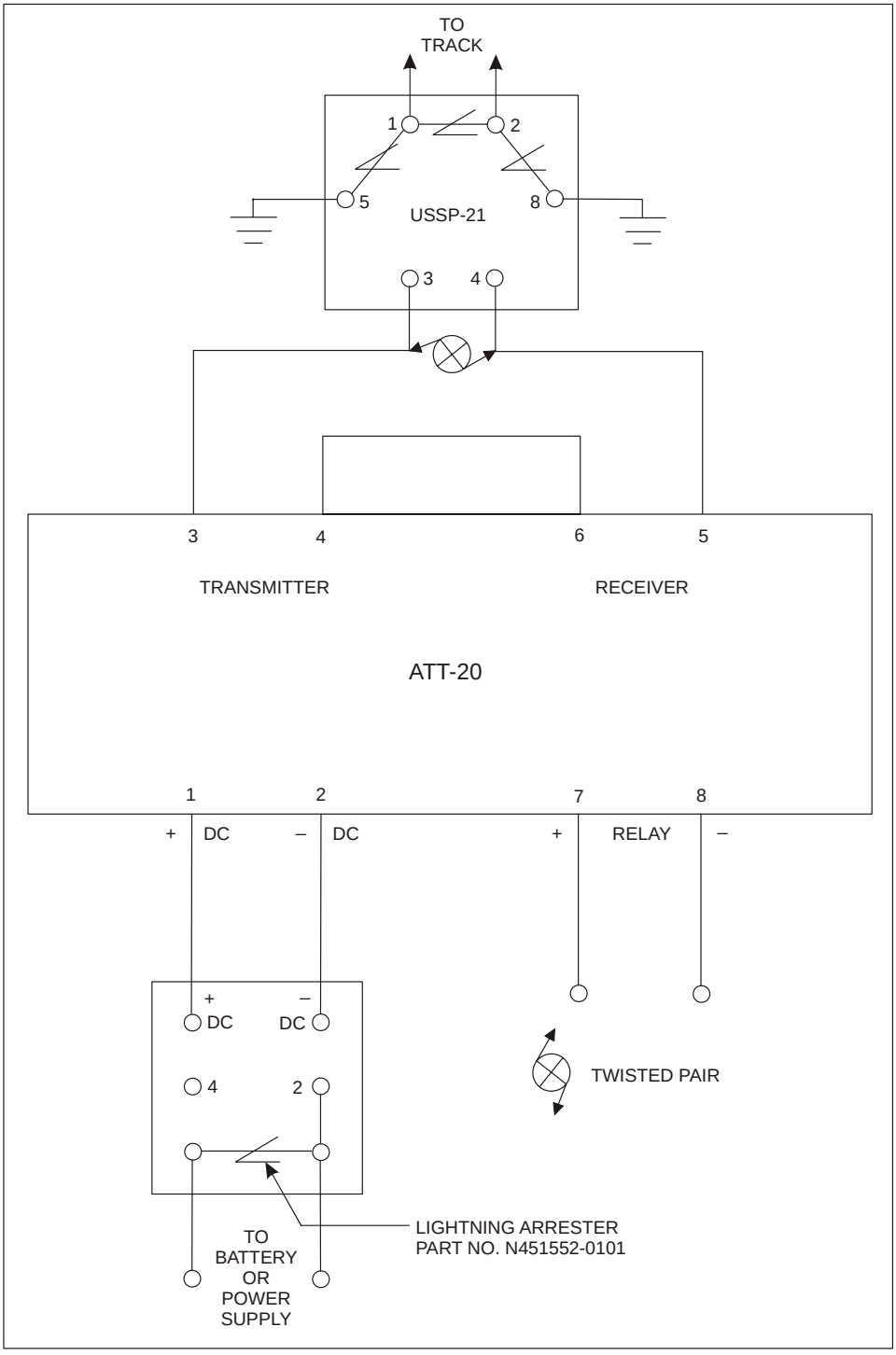

Figure 2-4. Lightning Arrester and Surge Ripple Filter for Series Mode Application


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3. FUNCTIONAL DESCRIPTION

3.1. General

The transmitter produces an output signal in the high audio frequency range and is sine wave modulated to provide noise immunity. First, the receiver detects the modulation information signal. It then amplifies and rectifies this signal to provide a DC output which drives the relay coil. Functional description of the ATT-20 applied to the shunt track circuit is covered in Section 3.2. Section 3.3 covers the series mode track circuit.

3.2. Shunt Mode Track Circuit

As illustrated in Figure 2-1, the transmitter output and receiver input are cabled directly to the rails. The point at which the transmitter wires are connected defines one end of the track circuit. The other end of the track circuit is defined by the receiver connections to the track. The receiver detects the presence of a train by the loss of the audio frequency signal which is shunted away by the train axle.

The shunt mode of operation is defined as a vital application.

3.3. Series Mode Track Circuit

As illustrated in Figure 2-2, the transmitter and receiver are wired in series via a jumper located on the ATT-20 unit. This jumper connects the transmitter output terminal to the receiver input terminal. The remaining transmitter output lead and the remaining receiver lead are twisted as a pair with each is connected to its respective rail. The presence of a train axle across the rails completes the series signal path, thus detecting the presence of a train

The series mode of operation is a non-vital application.

3.4. Detailed Circuit Description

3.4.1. Transmitter

The transmitter circuit diagram is shown in Figure 3-1. Transistor Q1 and its associated circuitry comprise the modulation oscillator which produces 390 Hz. A constant signal level is maintained by Zener diode D1. Transistor Q2 buffers the modulation oscillator.

Transistor Q7 and its associated circuitry comprise the carrier frequency oscillator. Selection of capacitor C3 determines the carrier frequency.

Transistors Q3, R8 and R13 mix the carrier and modulation signals. Resistor R14 provides gain control. Inductor L1, capacitor C5, and resistor R17 form a bandpass filter which allows the modulated carrier to pass unaltered by low frequency or higher order harmonic disturbances.

Resistor R15 and R19 form a voltage divider which sets the bias for transistor Q4. Capacitor C12 bypasses resistor R19. Transistors Q4, Q5, Q6 and Q8 make up a unity gain amplifier with low output impedance. Diodes D4, D5, D6 and D8 - along with resistors R20 and R21 - serve to temperature compensate and bias both transistors Q5 and Q6. C13 is a bypass capacitor. Capacitor C6 and the primary of T3 couple the signal to the output circuitry.

Inductor L5, jumper J2 and capacitor C9 from the shunt mode output, providing an output impedance of 7 ohms.

Inductor L6, jumper J1 and capacitor C9 form the series mode output with an output impedance of 1 ohm.

Diode D7 prevents damage from reverse battery connection. Fuse F1 prevents damage from an overcurrent condition. Inductors L2, L3 and capacitor C11 provide RFI rejection. Capacitors C7 and C10 filter the power bus.

3.4.2. Receiver

The receiver circuit diagram is shown in

Figure 3-2. Capacitor C1, transformer T1 and resistor R1 form a medium Q input filter. Jumper positions should be J1 and J3 for both shunt and series mode boards. The input impedance is primarily determined by R1 (Shunt boards = 7 ohms, series boards = 1 ohm). Transistors Q1 and Q2 form a Darlington pair emitter follower which buffers the input signal. Resistor R4 and Zener diode D10 provide a fixed bias voltage for Q1 and Q2.

Inductors L3 and L4; capacitor C3, C4 and C5; and resistors R6 and R7, together form a high Q bandpass filter. Diode D1 demonstrates the signal. Resistor R8 and capacitor C6 filter the carrier frequency. Transistor Q3 and its associated circuitry form an emitter follower to buffer the demodulated signal. Resistor R13 is selected to provide an input sensitivity of 70 mVrms (modulated signal).

Transformer T2 and capacitor C9 form the demodulated filter. Transistors Q4 and Q5 are configured as an emitter follower which buffers the demodulated signal. Capacitors C11 and C12, along with diode D3 and D4, form a voltage doubler. This doubler produces a negative DC voltage which drives a level detector.

The level detector consists of resistor R17 and diode D5. Once in conduction, D5 provides the feedback path necessary for Q6 and its associated circuitry to behave as an oscillator. The oscillator frequency is approximately 25 KHz. The output of the oscillator is buffered by transistor Q7 and Q10. Transistors Q8 and Q9 amplify the signal. Diodes D7 and Q11, along with capacitors C17 and C8, form a voltage doubler. They also rectify and filter the signal to provide a negative DC voltage to drive an external relay. The Q11 circuit decreases relay drop away time in lieu of the standard 2-diode voltage doubler circuit. Inductors L1, L2, L6, and L7 (along with capacitors C19 and C7) provide RFI rejection. Capacitor C10 filters the power bus.

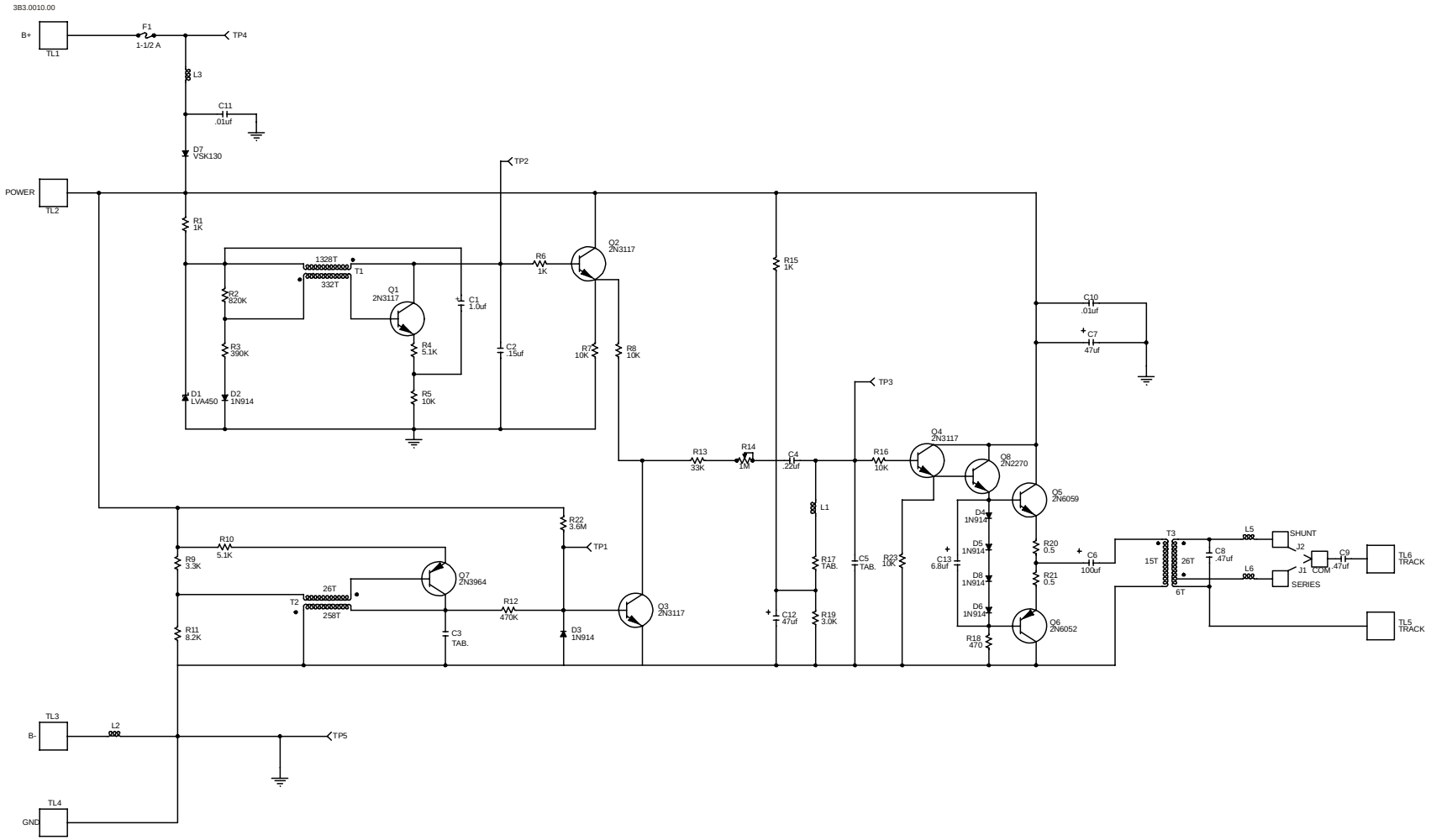

Figure 3-1. Transmitt6er PCB Schematic Diagram

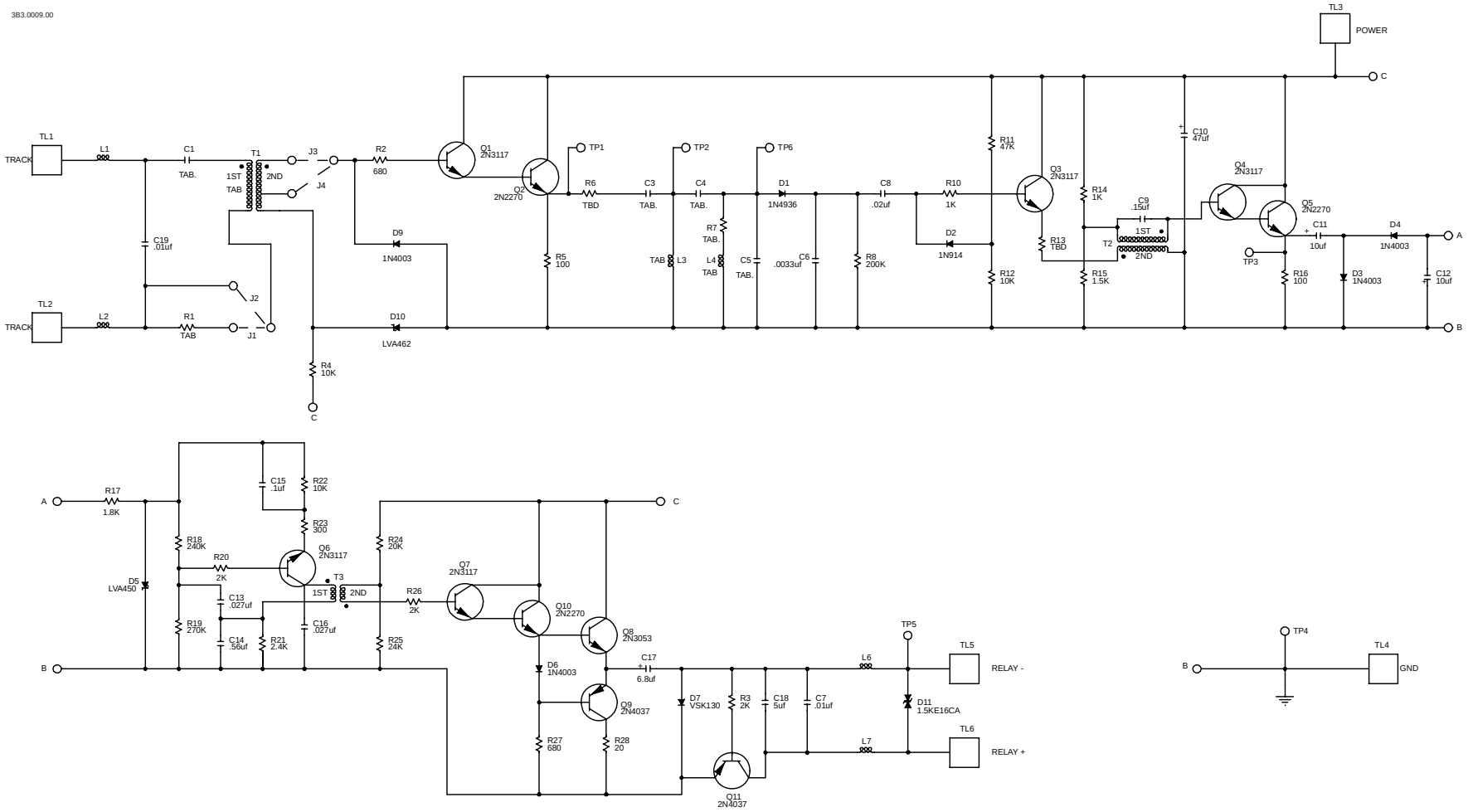

Figure 3-2. Receiver PCB Schematic Diagram

4. FIELD MAINTENANCE

4.1. General

The following procedures may be used to check the ATT-20 at its field installation. These procedures should also reveal whether the fault is in the ATT-20 or a related unit or circuit. If fault lies with the ATT-20, the ATT-20 should be replaced with a new unit. When installing the new unit, please make certain to follow all installation procedures outlined in Section II. Replacement units may be obtained through the US&S Sales Office.

4.2. Test Equipment

- True RMS reading DMM (Fluke 8010A or equivalent).
- 5.0 ohm, 5 watt resistor 1%
- 1.0 ohm, 5 watt resistor 1%

4.3. General Checks

a. Inspect all leads for breaks and loose terminal connections.

b. Check power supply voltage at terminals 1 (+) and 2 (-). The voltage should be 12 Vdc nominal (9.8 to 15.8 Vdc maximum). Ripple voltage should not exceed 1.0 Vpp.

c. Check the fuse on the transmitter-circuit board. If it is open, replace it with a 3.4 Amp fast blow fuse. If the fuse is intact, disconnect the transmitter and receiver track connections at the unit. To test for proper operation in the shunt mode, refer to Section 4.4. To test for proper operation in the series mode, refer to Section 4.5.

4.4. Shunt Mode Checks

a. Connect the ATT-20 as shown in Figure 4-1.

b. Turn fully clockwise the “transmitter level adjust”. If the relay picks, proceed to step c below. But if the relay does not pick, check the relay connections for proper polarity and open circuits. If the same relay connections are good, replace the ATT-20 with one of a unit of the same operating frequency and repeat steps a and b. If the relay still does not pick up, replace it with another PN-150B, 400 ohm coil (US&S Part No. N322500-701).

c. If the relay does pick, disconnect the circuit of Figure 7. Measure the open circuit volt-age across terminals 3 and 4. The voltage should be equal to or greater than 2.3 Vrms. If this voltage should be equal to or greater than 2.3 Vrms, reconnect the circuit of Figure 7. Adjust the transmitter level so that it will only pick the relay. Measure the voltage across terminals 5 and 6 (receiver input). This voltage should be 70 mVrms + 14 mVrms. If not, replace the ATT-20 unit.

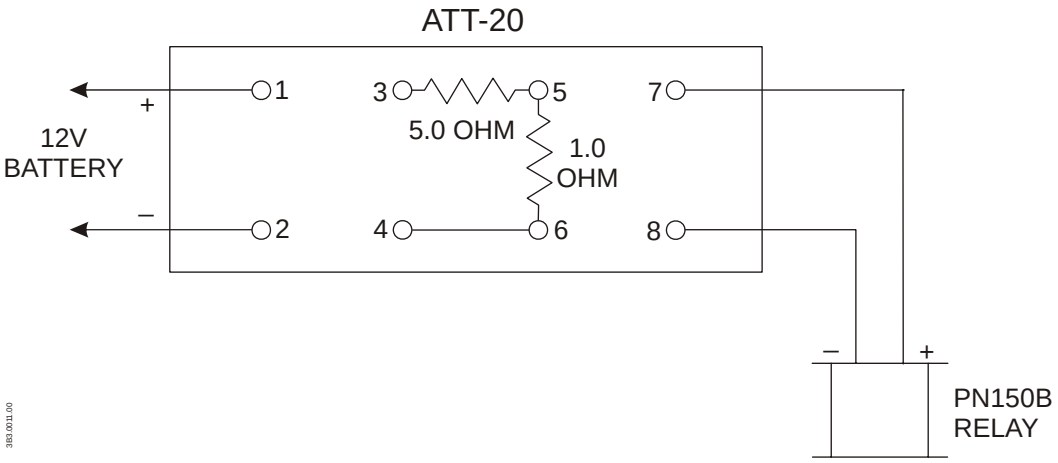

Figure 4-1. ATT-20 Test Circuit for Shunt Mode Application

The tests performed in Section 4.3 verify proper operation of the ATT-20 unit in a shunt mode application. If the track circuit installation still does not work properly, proceed to troubleshoot the cabling, connections and peripheral equipment associated with the track circuit.

4.5. Series Mode Checks

a. Connect the ATT-20 as shown in Figure 4-2.

b. Turn the transmitter level adjustment fully clockwise. If the relay picks, proceed to step c, listed below. If the relay does not pick, check the relay connections for proper polarity and open circuits. If the relay connections are good, then replace at ATT-20 with a unit of the same frequency and then repeat steps a and b. If the relay still does not pick, replace the relay with another PN-150B, 400 ohm coil (US&S Part No. N322500-701).

c. If the relay picks, disconnect the circuit of Figure 8. Measure the open circuit voltage across terminals 3 and 4. This voltage should be greater than or equal to 0.4 Vrms. Replace the ATT-20f the open circuit voltage is less than 0.4 Vrms. But if this voltage is greater than or equal to 0.4 Vrms, reconnect the circuit which appears in Figure 8. Then adjust the transmitter level to only pick the relay. Measure the voltage across terminals 5 and 6 (receiver input). This voltage should be 70 mVrms + 14 mVrms. If not, replace the ATT-20 unit.

The tests performed in Section 4.4 verify proper operation of the ATT-20 unit in a series mode application. If the track circuit installation still does not work properly, proceed to troubleshoot the cabling, connections, and peripheral equipment associated with the track circuit.

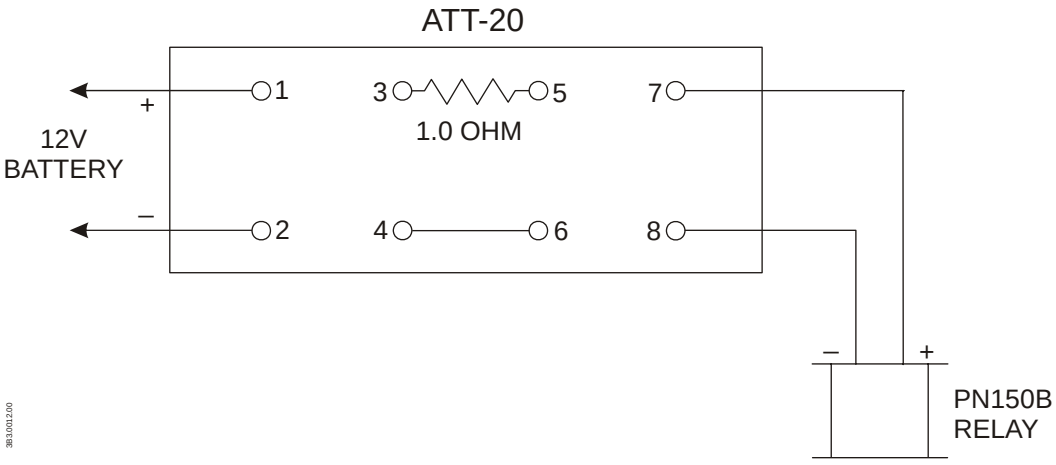

Figure 4-2. ATT-20 Test Circuit for Series Mode Application


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5. SHOP MAINTENANCE

US&S recommends that faulty ATT-20 units be returned to the factory for shop level testing and repair. Both the transmitter and receiver PCB's must undergo special testing, calibration, and component replacement (per frequency) procedures. If board level maintenance is to be attempted, contact US&S Engineering for special instructions. Appendix A provides a complete listing of all transmitter and receiver PCB components.


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6. PARTS LISTS

6.1. ATT-20 Audio Track Receiver Kits

Each kit consists of a complete ATT-20 unit for series mode application and the Cable Compensating PCB.

Table 6-1. ATT-20 Unit Kits

US&S Kit Part No,	ATT-20 Unit	Cable Compensating PCB	Application
X451052-3907	N451052-3904	N13100201	Series
X451052-3908	N451052-3905	N13100201	Series
X451052-3909	N451052-3906	N13100201	Series

6.2. ATT-20 Audio Track Transceiver Units

Table 6-2. ATT-20 Unit (Only)

US&S Part No.	Frequency (KHz)	Application
N451052-3901	12.28	Shunt
N451052-3902	15.00	Shunt
N451052-3903	20.00	Shunt
N451052-3904	12.28	Series
N451052-3905	15.00	Series
N451052-3906	20.00	Series

Table 6-3. Miscellaneous Application Units

Item	US&S Part Number	Application
Secondary Surge Protector USSP-21	N451522-0525	Between ATT-20 unit and track
Surge Ripple Filter	N451890-0301	Between ATT-20 power input and DC source
Lightning Arrestor	N451552-0101	Across battery terminals of Surge Ripple Filyer
Cable Compensating PCB	N1310-0201	

6.3. ATT-20 Audio Track Receiver Parts List

The following tables contain a complete parts list for ATT-20 Audio Track Transceiver units N451052-3901 through -3906. Refer to Figure 6-2.

Table 6-4. ATT-20 Unit Parts List

Item	Part Number	Description	Quantity
5	Refer to Table 6-5	CHASSIS	1 EA
10	R438872	COVER	1 EA
15	Refer to Table 6-5	PCB,ATT-20 TRANSMTTER	1 EA
20	Refer to Table 6-5	PCB,ATT-20 RECEIVER	1 EA
25	M181829	4 WAY BLOCK	1 EA
30	J5252720110	SCREW-10-32X5/8 SST	2 EA
35	J047733	WASHER,10 STEEL LOCK MED	2 EA
40	J048172	NUT,10-32 HEX STEEL	2 EA
45	J047818	WASHER,17/64X9/16 COP	40 EA
50	J480300	NUT,14-24 HEX BRASS NP	16 EA
55	J480301	NUT,14-24 HEX BRASS	16 EA
60	J525111	SCREW,8-32X1-1/4 RD HD STEEL	4 EA
65	J047714	WASHER-8 SHPRF LK SS	4 EA
70	J048166	NUT,8-32 HEX STEEL	4 EA
75	M337854	INS TUBING	8 EA
80	J052686	SCREW,8X3/8 RD HD	4 EA
85	J730041	TERM-PRE-INSUL DIAGR	8 EA
90	J078399	BAG-PLASTIC,#60F-0406	1 EA
100	S705.11	WIRE,TAG 12" BUNDLE	1 EA
105	J075415	GROMMET,RUBBER 3/8"ID	1 EA
110	A774169	TUBING.HT SHRINK 3/16ID	1 FT
115	A774184	TUBING SHRINK FIT 1/16	1 FT
120	A434083	CA-1 TW.PR.SHELDD. MIN	6 FT
125	J703310	CABLE TIE, SELF LOCKING	5 EA

Table 6-5. ATT-20 Part Tabulation

ATT-20 Unit	Freq. (KHz)	Application	CHASSIS Item 5	XMITER PCB Item 15	RCVR PCB Item 20
N451052-3901	12.28	Shunt	R451053-6302	N451605-6402	N451605-6502
N451052-3902	15	Shunt	R451053-6302	N451605-6403	N451605-6503
N451052-3903	20	Shunt	R451053-6302	N451605-6404	N451605-6504
N451052-394	12.28	Series	R451053-6303	N451605-6405	N451605-6505
N451052-3951	15	Series	R451053-6303	N451605-6406	N451605-6506
N451052-3961	20	Series	R451053-6303	N451605-6407	N451605-6507

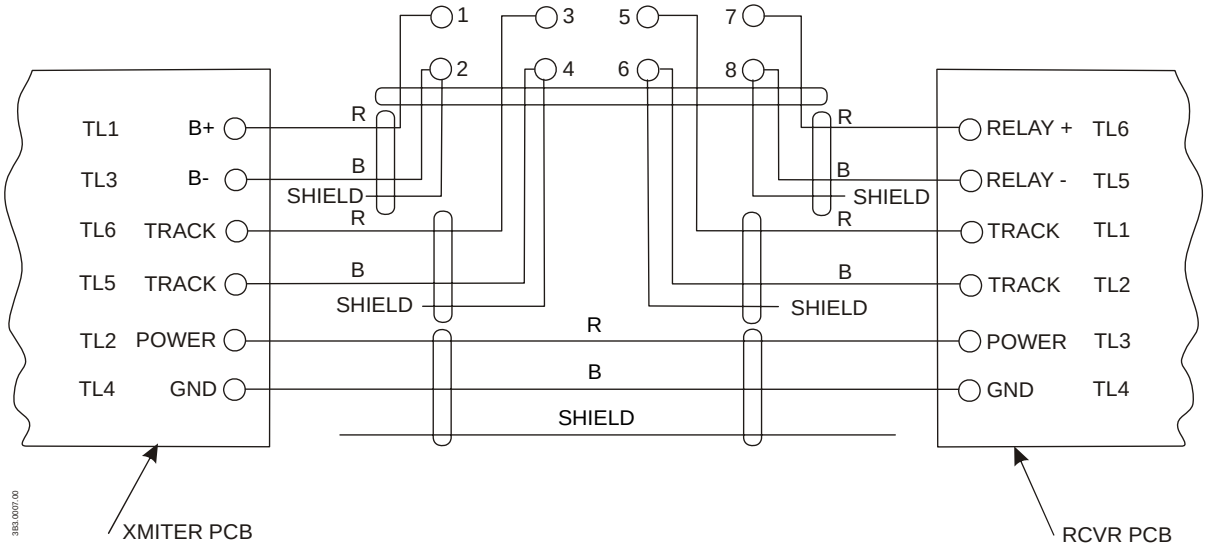

Figure 6-1. ATT-20 Wiring Diagram

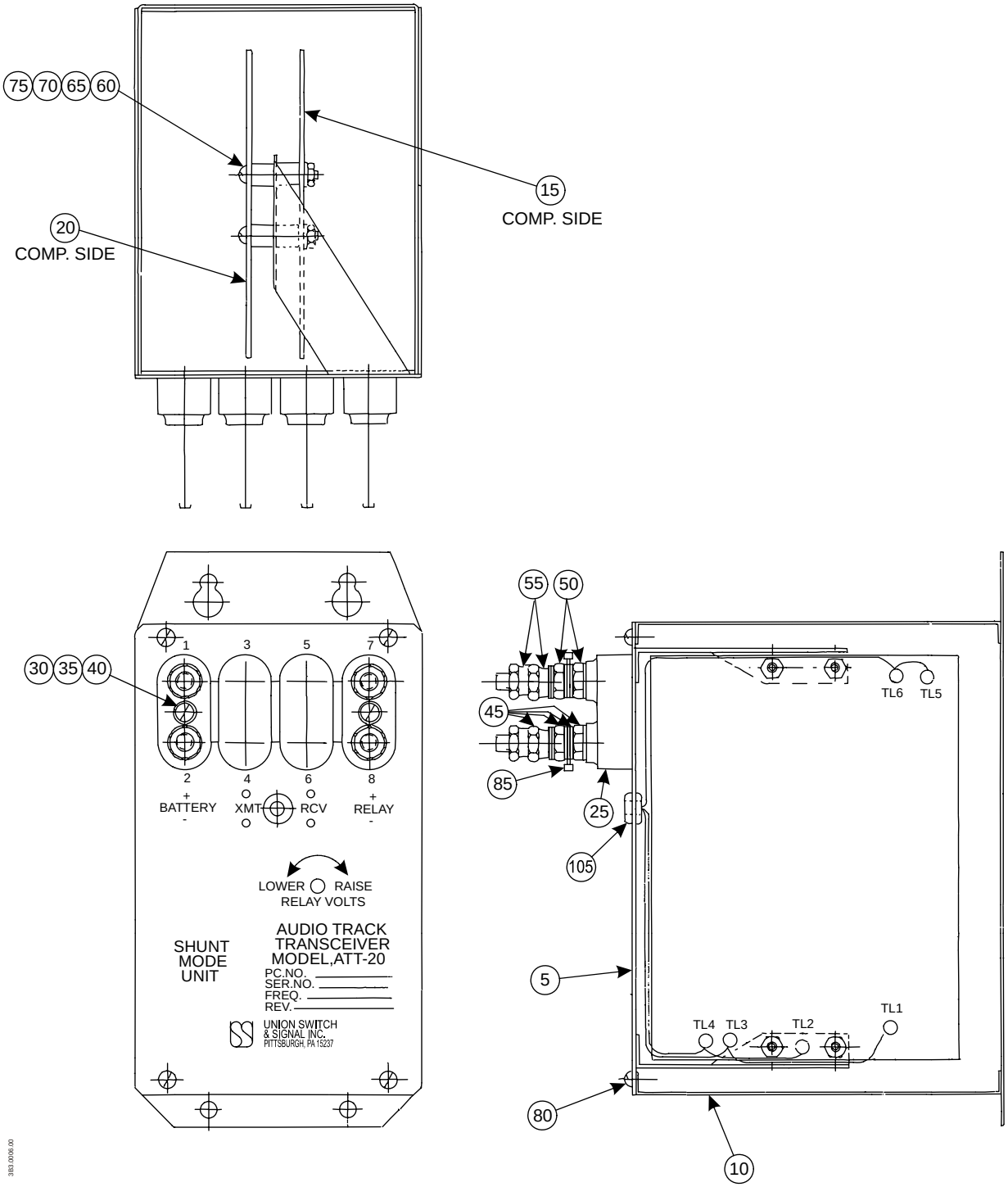

Figure 6-2. ATT-20 Parts Illustration

6.4. Cable Compensating PCB Parts List

Refer to Table 6-6 and Figure 6-3 for Cable Compensating PCB, US&S N13100201, parts, parts layout, and schematic diagram.

Table 6-6. Cable Compensating PCB Parts List

Item	Part No.	Description	Quantity
5	N381621	BLOCK,TERM	1 EA
10	N13100101	PCB,CABLE COMPEN	1 EA
15	J047818	WASHER,17/64X9/16 COP	2 EA
20	J5000970128	SCR-SST 1/4-20X1-3/4	2 EA
25	J4751200112	WASHER,SST PLATE NO1/4	2 EA
30	J4751210111	WASHER,SST LOCK NO1/4	2 EA
35	J4802110108	NUT,1/4-20 SST HEX	2 EA

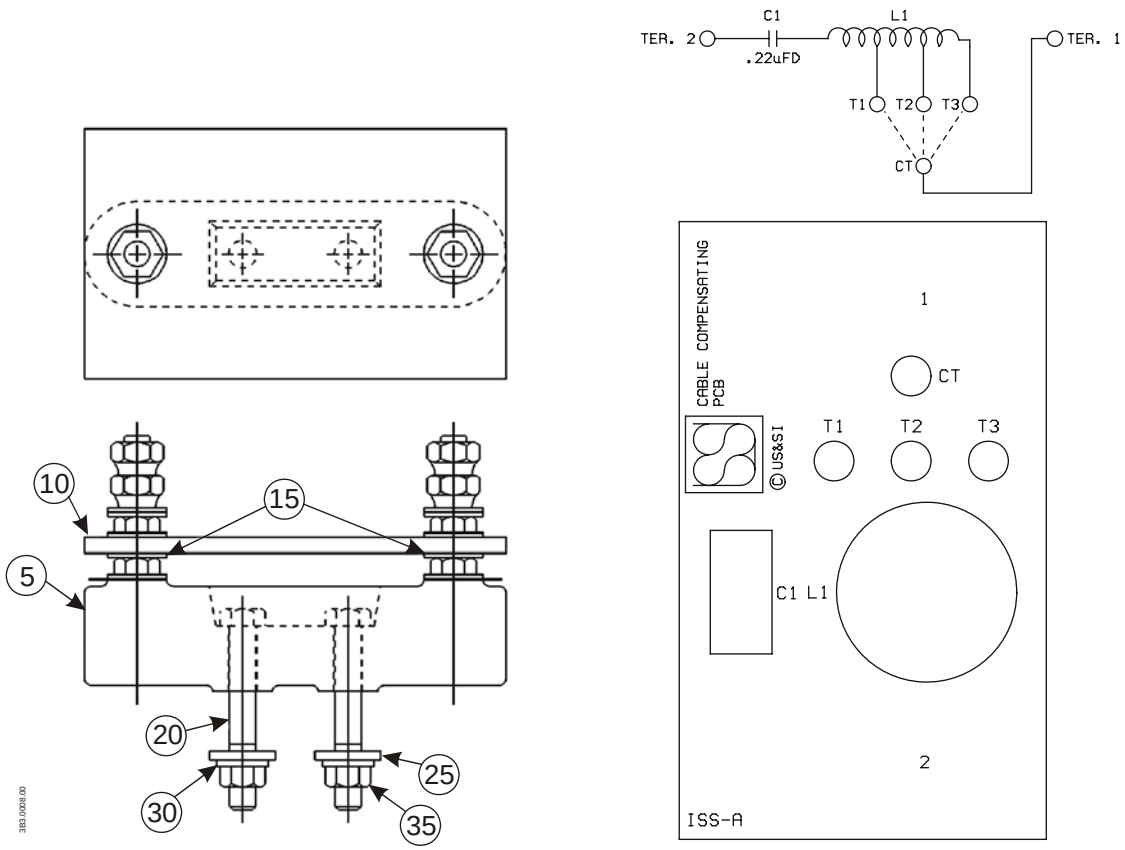

Figure 6-3. Cable Compensating PCB Parts Layout and Schematic Diagram


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7. RAIL TEAM AND TECHNICAL SUPPORT

The Rapid Action Information Link Team (RAIL Team) is a group of experienced product and application engineers ready to assist you to resolve any technical issues concerning this product. Contact the RAIL Team in the United States at 1-800-652-7276 or by e-mail at railteam@switch.com.

End of Manual